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REPORT ON A COOPERATIVE SEED & CONE INSECT SURVEY IN THE NORTHEASTERN REGION, 1963-64

BY

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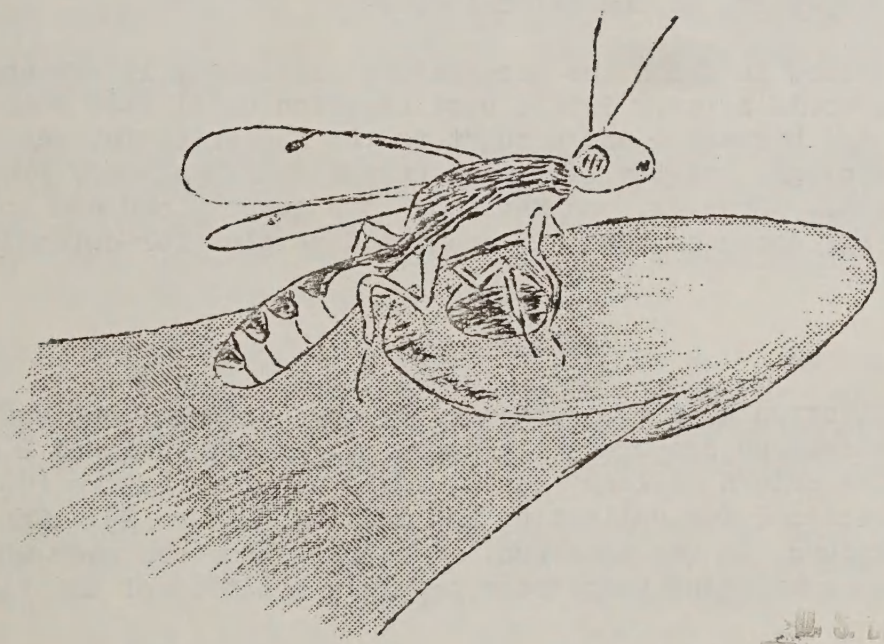

NORTHERN FOREST PEST CONTROL ZONE

FOREST SERVICE, R-7; U.S. DEPARTMENT OF AGRICULTURE

FEBRUARY 10, 1965

REPORT ON A COOPERATIVE SEED & CONE INSECT SURVEY IN THE NORTHEASTERN REGION, 1963-64

INTRODUCTION

This is the first in a series of reports describing the progress and findings of a cooperative survey program for cone and seed insects in the Northeastern Region.

The program was initiated in the fall of 1963 at the Forest Tree Nurserymans' Annual Conference in Lowville, New York. The Forest Service was represented at the meeting by Regional and Northern Zone personnel. It was suggested that the first step in a cone and seed insect survey would be to identify the insects affecting seed production, determine their impact on seed crops, and provide some indication of their distribution. It was thought that this approach would help to place emphasis for research on those cone and seed insects most in need of control. Participants in the survey would include forest tree nurseryman and other interested individuals who would supply most of the infested cone material. The Northern Forest Pest Control Zone in Amherst volunteered to serve as a clearing house for the infested cones by identifying the damaging insects, maintaining records on occurrence and distribution, and notifying the submitting cooperator of the determination.

Because of the period in which the program was initiated, it was anticipated that there would be very little participation until late summer of 1964 when cones are harvested and brought to the nurseries for seed extraction and storage. At the time most nurseries had already processed their cone material. However, one Massachusetts nursery had one lot of infested balsam fir cones on hand and submitted samples for determination.

METHODS

Thirty-three collection kits were prepared by the Northern Zone and mailed to all interested cooperators (Figure 1). A kit included 2 or 3 mailing tubes with return mailing labels, vials of preservative (70% alcohol) and directions for collecting and mailing (Figure 2). When the material was received, it was examined, a determination was made when possible, and the submitting cooperator promptly notified of the findings by letter.

Realizing that the 1964 cone crop would not be harvested until late summer, additional collections of cones were made throughout the 1964 growing season by Zone personnel. In some instances a few cone species were collected at periodic intervals in the same general area to observe cone formation, pollination, and cone development; and for additional information on the habits of insects that attack them. Supplemental collections were made by Zone personnel and other forest workers during the growing season while performing other duties.

Cover: Drawing of a male balsam-fir seed chalcid, Megastigmus specularis, emerging from a balsam fir seed in which it overwintered.

The cones were individually examined for insects. When possible, notes were made of the development stage of the cone, exterior and interior damage symptoms, the life stage of the insect when present and its pattern of feeding. A few records were made of the extent of damage, particularly with those specimens collected at maturity. With specimens collected earlier, it was possible to record more than one life stage of an insect. In one instance it was possible to follow the development from egg to adult; with a few others, from egg to pupa.

Attempts were made to rear the cone inhabiting insects through to adults. However, this was not possible in all cases, particularly with those cones collected prematurely where the inhabiting larvae were deprived of moisture and nourishment, or when the cones were dissected and the insects' habitat was destroyed. Under these circumstances the larvae or other life stage was preserved in 70% alcohol.

Cones containing live insects were placed in transparent plastic boxes (various sizes) with holes cut in the sides to provide ventilation. The holes were covered by fine mesh copper screen. Rearing was undertaken throughout the summer and early fall in a non-air conditioned, poorly ventilated laboratory. The insects were subjected to relatively high temperatures through the rearing period resulting in desiccation and subsequent mortality. Corresponding humidity caused mold to form and develop on many of the cone specimens resulting in additional insect mortality (Figure 4).

Those insects that failed to pupate and/or emerge and appeared to enter diapause or overwinter as pupae were transferred to an unheated garage where they will overwinter and be observed for emergence next spring. Those that have extended diapause, or pass a second winter as pupae, will be left in rearing until emergence occurs.

The puparia of one dipterous species (Earomyia sp.) were placed out-of-doors in specially constructed containers where they will be free of parasites and predators, but subjected to the varied temperature and humidity regimes encountered in their natural environment (Figure 5).

Observations of insect activity were supplemented by color photography. During this investigation more than 100 relevant color transparancies were obtained. Emphasis was placed on external damage symptoms exhibited by the host cones. Partial series were obtained of one or more life stages of the damaging insects involved. Occasionally it was possible to take pictures of live, newly emerged adults.

Determinations were made from adult specimens when possible. When emergence did not occur, particularly with those insects that overwinter as larvae or pupae, identification was made on the basis of larval and pupal characteristics, and in some cases, on the characteristic of feeding damage. The latter method was used in a few instances whenever insects were absent. Final determinations of adult specimens were made by specialists in the U. S. National Museum.

FINDINGS

A complete list of the collections received and determined is shown in Figure 3. A total of 25 collections were received, representing 10 coniferous species from 9 eastern states. Of these only 4 collections were made by nurserymen; 11 of the remaining 21 were made by Clyde Hunt, Regional Geneticist.

A discussion of the insects associated with several cone species submitted by cooperators and from additional material collected by Zone personnel follows. They are listed by order, family, genus and species.

COLEOPTERA

(SCOLYTIDAE)

Conophthorus coniperda.--(White-pine cone beetle)--White pine is the most important conifer in the Northeast. The white-pine cone beetle is easily the most destructive of white pine cones. The biology and habits of the beetle as well as its impact on cone crops and regeneration is well known (10)(1). Collections containing the cone beetle were received from the extreme ranges of white pine in the east--Maine in the north to Kentucky in the south. The range of the beetle coincides with the natural range of white pine (10). Fortunately white pine is its only known host, although other species of Conophthorus are destructive on cones of other pines elsewhere (3)(4).

A brief description of the habits of the white-pine cone beetle follows: In the Northeast the beetle concentrates its attack on second year cones during April and May. It burrows into the base of the cone near the petiole, girdling the cone completely (Figure 6). The female beetle enters first followed by the male. If the female is accompanied by a male, she tunnels parallel to the rachis depositing eggs on the way. If not joined by the male, she leaves the cone and attacks a second cone. Following eclosion, the young larvae feed on seeds and cone tissue and continue to devour the inner cone as they develop. Pupation takes place within the cone and although there is some emergence in the fall by young adults, most of them remain in the cones where they pass the winter. Those beetles that emerge attack newly developed conelets or enter fallen cones on the ground. Emergence occurs the following spring.

LEPIDOPTERA

(OLETHREUTIDAE)

Eucosma tocullionana Hein.--This insect has been observed feeding in cones of white pine (Pinus strobus), balsam fir (Abies balsamea), Norway spruce (Picea abies), and possibly red spruce (Picea rubens). Adults were successfully reared from white pine and balsam fir.

The following partial description of its life history and feeding habits will emphasize its activity in balsam fir. Far more detailed observations were made on its association with balsam fir than the other cone species.

Eggs were first discovered on the ovulating cones on May 18 near Savoy, Massachusetts. They are laid in a small mass (2-3 per mass) on the upper portion of the cone bract near the tip. In the laboratory the eggs hatched by June 1 but the young larvae died before they could be transferred to fresh cone material.

The larvae of E. tocullionana feeds entirely within the cone, consuming seeds, seed wings and cone scales (Figure 7). One larvae can destroy 30-40 percent of the seed. It is not uncommon to find 2 or 3 larvae per cone in which case the cones contents are completely destroyed. Six partially grown larvae were found in one cone. The maximum number of larvae that one cone can support is unknown, but there have been several instances where three E. tocullionana larvae had fed, developed and pupated in the same cone. In one Norway spruce cone, two E. tocullionana pupae were found with a Dioryctria abietella pupa, indicating successful competition in the same cone between two species with dissimilar feeding habits.

Pupation occurs in a silk lined cocoon in the cone, on the surface of the cone, or on the bottom of the rearing container. In the laboratory the first pupa was found July 14. In the field, however, cones collected July 15 contained only partially grown larvae. These cones, held in the laboratory, did not produce E. tocullionana adults until August 17 (Figure 9). With most of the pupae, however, emergence did not occur and it is probable that they will overwinter and emerge the following spring. From this it is assumed that there is at least one and possibly a partial second generation per year.

Balsam fir cones inhabited by E. tocullionana do not exhibit noticeable damage characteristics until late in the growing season. When the cone is nearing maturity, and the scales begin to open, the frass accumulated by the larvae within the cone begins to extrude from between the scales. The amount of frass is proportional to the number of feeding larvae within the cone. The frass is loose, tan in color and of a relatively light texture making it easy to differentiate from the castings of D. abietella.

In red spruce, E. tocullionana feeds at the base of the cone scales, partially or completely severing them from the cone axis, causing individual scales to die. The severed scales soon turn brown and form a distinct contrast between them and the adjacent green scales (Figure 10).

The individual eggs are round, red-orange in color, and measure .65 mm in diameter. They overlap one another like shingles. Prior to eclosion they change color to dark brown.

The larvae range in length from $\frac{1}{2}$ to 5/8 of an inch when full grown. At first the young larvae are cream colored with the head and prothoracic shield jet black, changing to tan when mature. The body remains cream colored or off-white, tinged with pink dorsally. The number of instars are unknown.

Pupae are 7-9 mm long, dark brown with rows of posteriorly pointed spines surrounding the abdominal segments (Figure 8). The spines are larger and more closely spaced dorsally than ventrally. The head contains a small beak-like projection.

The adults are small, vari-colored moths with a wing expanse of 5/8 inch (Figure 9). The forewings are reddish-brown with two wide beige-colored bands, each bordered by narrow bands of dark brown scales. The hindwings are light brown.

A small wasp, Elachertus pini Gahan, was reared from balsam fir cones presumably infested with Eucosma spp. Eucosma spp. is thought to be its host. Keen (3) has found Elachertus spp. to be parasitic on lepidopterous larvae in cones of several western conifers.

Eucosma sp.--Pupae of this unknown species were observed in balsam fir cones in association with E. tocullionana. The pupae is reddish-brown but differs from E. tocullionana in that it is 2-3 mm larger, its abdominal spines do not reach the ventral portion, and lacks the beak-like projection on the front of its head (Figure 8). No other stage of this cone worm was observed. Pupae are being reared and emergence will probably occur this spring.

(PHYCITIDAE)

Dioryctria abietella.--Larvae were observed feeding in cones of white pine, balsam fir, Norway spruce and possibly red spruce (Figure 12). The live stages of D. abietella in cones of several western conifers and red pine in Canada have been described (3)(5).

The extent of damage wrought by one larva of D. abietella varies between cone species and appears to be inversely proportional to the size of cone it attacks. For example, one D. abietella larvae can completely destroy a red spruce cone, but only 15-25 percent of a Norway spruce cone. Regardless of cone species or size, the outward symptoms of attack by D. abietella is the same. It is characterized by a large mass of relatively course frass webbed together on the surface of the cone directly covering the point of attack (Figure 15).

On Norway spruce cones this large circular ball of frass sometimes exceeds 3/4 of an inch in diameter (Figure 14).

In cones of Norway spruce and balsam fir, pupation, in a few instances occurred within the cones (Figure 13) and the moths emerged one or two weeks later (Figure 11). Commonly, however, the mature larvae leave the cone, wander aimlessly in the rearing container and eventually encase themselves in a frass-covered silk web in which they overwinter. Whether this partial second generation exists in nature in the Northeast is unknown. Keen (3) found a partial second generation of D. abietella in fir in the west but only a single generation in pine. Lyons (5) reported only one annual generation in red pine in Ontario.

Table 1 shows the damage to balsam fir cones by D. abietella as represented by a ten cone sample.

A single Ichneumonidae parasite (determination pending) was reared from a balsam fir cone and a D. abietella larva is suspected of being the host.

(TORTRICIDAE)

Clepsis persicana (Fitch).--A mature larva was found in the field on May 21 feeding on the ovulating cones of balsam fir (Figure 16). It was brought into the laboratory, placed on freshly cut branches containing ovulating flowers and allowed to feed. Pupation occurred one week later and the adult emerged June 1. In less than one week of feeding activity this single larva fed on four ovulating flowers, and destroyed two of them completely.

The mature larva was 7/8 inch long, light green in color with a tan head and a lightly sclerotized prothoracic shield. Pupation occurred in a loosely spun web on the side of a partially destroyed ovulating flower.

DIPTERA

(LONCHAEIDAE)

Possibly Earomyia sp.--Of the many insect species that attack balsam fir cones in the Northeast, this species is probably the most destructive and widespread of them all. All life stages, with the exception of the adult, have been observed. Pupae are in rearing now and emergence may occur this spring or next. Some species of Earomyia spend one, two and sometimes three winters as puparia (8).

Oviposition occurs when the cone is open for pollination. The egg is deposited on the upper surface of a bract near the tip and eventually becomes covered by an expanding cone scale. One cone contained 19 eggs, all deposited on separate bracts.

The length of the incubation period is unknown, but it is suspected that complete egg hatch occurs no later than two weeks following oviposition. The newly hatched maggot moves down the cone scale toward the rachis and bores into the soft seed coat, directly into the seed. As the larva develops it moves from seed to seed (Figure 17) constructing progressively larger holes in the seeds as it grows (Figure 18). No accurate count of the number of seed destroyed by one maggot was made, but there is little doubt that one maggot can destroy a minimum of 6 to 8 seed. Table 1 shows the percentage of balsam fir seed destroyed in one collection of 10 cones.

The cone matures with almost no external evidence of infestation or damage. The period of emergence from the cone for pupation occurs through late summer and early fall. Most larvae leave the cone before it is mature; others wait until the cone dries out and begins to desintegrate; while a few remain in the fallen seed. In all cases pupation occurs in the soil (Figure 19) and the winter is passed in this stage.

The egg is white in color, cigar-shaped and averages .75 mm in length. The newly hatched maggot is white in color, legless, and .60 mm long. The mature larvae remain white, turning pink prior to pupation and reach a length of 4 mm. The puparia are reddish-brown, cylindrical with rounded ends, 4.1 mm long and 1.6 mm wide.

(MUSCIDAE)

Possibly Hylemya (Pegohylemyia) sp.--This insect was found in collections of balsam fir cones from Greenbush, Maine, and Savoy, Massachusetts. This maggot is considerably larger and has different feeding habits than Earomyia sp.

The female deposits her eggs directly on the surface of the cone after pollination has terminated and the cone is fully closed (Figure 20). In several instances, eggs were found under the protruding bracts, near the cone's base. The maggot enters the cone usually near its base and begins to feed upward through the seeds, parallel to the rachis, packing its frass behind it. After it reaches the midway point, it begins to feed in a spiral pattern, circling the rachis and gradually moving upward toward the cone apex (Figure 21). In this way one larva can destroy practically all of the seed in the apical half of the cone. By late June feeding ceases, the larva tunnels out of the cone near the apex, and drops to the ground to pupate.

All attempts to recover puparia of this insect failed. Evidently the required temperature and humidity regimes are critical, and could not be duplicated in the laboratory.

The appearance of the mature maggot is similar to Pegohylemyia anthracina, as described by Tripp (11), in cones of white spruce.

Hylemya (Pegohylemyia) anthracina (Czerny).--White spruce (Picea glauca) cones damaged by H. anthracina were collected from Stratton, Maine and Fabuis, New York. At the time of collection, the insect had left the cone to pupate and only its damage was observed (Figure 22). Its life cycle and feeding habits in white spruce cones are described by Tripp (11)(12).

(CHLOROPIDAE)

Hapleginella conicola (Greene).--Balsam fir cones from Savoy, Massachusetts, yielded adult specimens of this small chloropid. Any damage to the seeds or portions of the cone caused by this insect was obliterated by the activity of Hylemya sp. It may possibly be predatory or simply a scavenger feeding on decaying cone parts.

(DROSOPHILIDAE)

Chymomyza amoena.--Adults of this species were reared from balsam fir cones collected at Greenbush, Maine. Its direct association with cones of balsam fir is unknown and nothing is known of its habits.

(CECIDOMYIIDAE)

Dasyneura sp.--Larvae of this midge were found to be generally destructive to seeds of balsam fir collected near West Stewartstown, New Hampshire. Nothing is known of its biology or life habits other than it feeds in individual seed.

The larvae is small with obvious abdominal segments, red-orange in color and bears a distinct Y-shaped, heavily sclerotized breastplate.

A Cecidomyid (A).--Larvae of this undetermined midge were found in cones of Eastern Larch (Larix laricina) collected near Grafton, New Hampshire. The larvae feed within the seed, and the cone exhibits no outward damage symptoms (Figure 23). A single midge larva is capable of destroying 50 percent of the seed in one cone. Of 50 cones examined, 48 (96%) of them were infested.

A Cecidomyid (B).--Collections of white pine (Pinus strobus) from somewhere in the Adirondack Region of New York and the Jefferson National Forest* in Virginia yielded small orange colored midge larvae of an undetermined species. Specimens from both locations are similar but may well be different species. Their role in regards to the host cone is unknown.

An unknown species.--Insect damaged Virginia pine (Pinus virginiana) cones were collected from two locations in West Virginia (Figure 3) and mailed for determination. The insect responsible for the damage had emerged, making a positive determination impossible. The feeding habits in the cones examined were similar, and appeared to resemble the workings of Hylemya spp. in white spruce and balsam fir.

A description of the damage and feeding characteristics follows: In the top third of the cone, the rachis was completely mined and packed with fine textured frass. Feeding then progressed downward toward the apex in a spiral pattern, through seeds and portions of seed wings and scales. The gallery ended in an oblong, frass-free hole near the apical third of the cone through which the insect emerged (Figure 24). No head capsules or other insect remains were found in all of the cones examined.

The feeding damage is extensive enough to cause browning of the apical half of the cone while the upper half remains green.

*Specific location omitted from collection slips--only "Adirondack Region" and "Jefferson National Forest" mentioned.

HYMENOPTERA

(TORYMIDAE)

Megastigmus specularis Wall.--Balsam fir cones containing this minute seed chalcid (Figure 25) were collected from West Stewartstown, New Hampshire, Greenbush, Maine, and Savoy, Massachusetts. Its biology and habits are reported by Hedlin (2). Its impact on balsam fir seed production from one area, in association with two other damaging insects, is shown in Table 1.

An extremely small, metallic green, chalcid parasite, Amblymerus sp., was reared from a M. specularis pupa.

Megastimus sp.--Larvae of this unknown species were found in seeds of red spruce collected at Savoy, Massachusetts. Observations on emergence will be made this spring.

CONCLUSIONS

The cooperative seed and cone insect survey was only partially successful. Some information was gained on the occurrence of a few cone and seed insects, their partial distribution, and a cursory look was taken at a few species whose occurrence and life habits are relatively unknown. Information as to the distribution of the most important seed and cone insects, and their impact on seed production of the primary Northeastern conifers is still lacking, however.

No red pine (Pinus resinosa) cones were collected but their principal insect enemies and their role in limiting seed production is adequately described (4)(5)(6)(7).

Contributions to the program have been mainly by Forest Service personnel. Only 4 collections were received by nurserymen--two submitted cones using the recommended procedures; two did not. The reason for this is that the nurseryman does not receive the cones until after the damage is done and the majority of insects have vacated. In most cases the nurseryman receives very few damaged cones for they are culled during collection. The more insidious insects, like Megastigmus spp., can go undetected and their real impact on seed loss is not discovered until it is too late, i.e., until germination. When this happens some other factor usually shares the blame.

RECOMMENDATIONS FOR FUTURE SEED AND CONE INSECT SURVEYS

Future surveys to record the presence of seed and cone insects, their distribution and effect on seed production should be undertaken with specific goals in mind and conducted in a systematic manner. More useful information can be obtained with the least effort by delegating survey responsibility to one organization and one individual. He should be aided by two part-time technicians: a collector and examiner. (Enlistment of

outside help should be considered only supplemental.)

The collector should be assigned a vehicle and allowed sufficient per diem to cover 40 days of travel. The examiner will remain in the laboratory and process the collections. Generalized suggestions concerning survey organization and procedure follows:

Responsibilities: The survey leader will be one of the zone entomologists. He will organize the survey, conduct and coordinate its progress and report on its findings. The activities of the collector, examiner and supplemental help will be the responsibility of the survey leader.

The collector's primary duty will be to make periodic collections of coniferous cones throughout New England and New York as specified by the Survey Leader. The Southern Zone could be included but would require additional personnel. When not in travel status, he will assist the examiner.

The examiner's principal function will be to process the collections in a systematic manner and make whatever observations the Survey Leader deems necessary.

Planning: The Survey Leader will contact the responsible state agencies for information on the location of major collecting areas and obtain permission beforehand to collect a specified number of cones, at specified times, from each area during the growing season. Additional inquiries as to the location of supplemental and/or alternate areas should be made in the event cone species or area location are not adequately represented. Once this information is obtained, specific areas can be designated prior to the actual survey. In selecting these areas and in making a decision as to the extent and frequency of sampling, some thought should be given to host tree distribution, cone abundance and the importance of a particular crop for seed.

Sampling procedures should be uniform. For instance, it may be decided that a sufficient sample from a given area will consist of 50 cones--25 cones from 2 trees, 10 cones from 5 trees, etc. Provisions should be made for periodic mailing of the field collections so as not to overload the examiner at any one time.

Conduct of the Survey: Collections of a single cone species should be made at least twice during the growing season in areas representing the parent tree's geographical range. The first collection should be made early in the growing season when most insects are present, and later, just prior to harvest when damage can be adequately assessed.

Examination should be systematic, by slicing the cones longitudinally, recording the presence of insects, their abundance, identifying species, their activity and nature and extent of damage. (A convenient method of assessing total cone damage by subsampling should be investigated.) Rearing adults and preserving larvae in their various development stages should be attempted whenever possible. All observations should be supplemented with color photography.

Adult specimens can be compared to the few determined specimens on hand or mailed to the U. S. National Museum for positive identification. All specimens submitted should be assigned a U. S. Hopkins number and recorded in the prescribed manner (9).

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TABLE 1--Balsam Fir Seed Damage in Ten Cones by Three Insects
Savoy, Massachusetts, 1963

Cone	Total Seeds Per Cone 1/	Dioryctria abietella	Earomyia sp.	Megastigmus specularis 2/	Undamaged	Total
	(Number)	(Percent)	(Percent)	(Percent)	(Percent)	(Percent)
1	181	0	52	--	48	100
2	165	0	36	--	64	100
3	209	0	27	--	73	100
4	196	0	41	--	59	100
5	282	78	10	--	12	100
6	212	12	6	59	23	100
7	218	0	2	49	49	100
8	202	39	26	18	17	100
9	132	0	30	36	34	100
10	271	20	21	42	17	100

1/ Only large, potentially viable seeds were counted. The small seeds near the apex were excluded.

2/ At the start of this investigation, M. specularis was not suspected and, therefore, not discovered until the sixth cone. Because of the time consuming process of opening individual seed, the "undamaged" seeds were subsampled in lots of 50. The percentages were then proportioned between M. specularis and the undamaged category.

FIGURE 1--List of State Forest Nurseries and Individuals in Region 7 Receiving Cone & Seed Insect Collection Kits--1963-64

Connecticut
John Olsen, Nurseryman
Pachaug State Forest Nursery
Voluntown

Delaware
W. S. Taber, State Forester
Dover

O. D. Bailey, Nursery Supervisor
Georgetown

Kentucky
John P. Rhody, Asst. Director
Div. Forestry, Dawson Springs

3 Nurseries:
Kentucky Dam
Morgan County
Pennyrile

Maine
Al Rollins, Nursery Supervisor
Passadumkeg

Maryland
H. C. Buckingham, State Forester
Annapolis

D W. Sowers W. Va. P&P Co.
Hancock

Silas Sines, Nurseryman
Harmons

Massachusetts
Roy Goodreau, Nurseryman
Amherst

Mr. Garfield, Nurseryman
Clinton

New Hampshire
Ingerson Arnold, Chief Nurseryman
Gerrish

New Jersey
Charles Dansbury, Nurseryman
Titusville

New York
E. G. Terrill, Nursery Supervisor
Saratoga

Robert Evans, Nursery Supervisor
Lowville

Pennsylvania
Joe A. Hill, Nursery Supervisor
Mont Alto

Patrick J. Lautz, Nursery Supervisor
Spring Mills

Newall M. Crownover, Nursery Supervis
Huntingdon

Charles Cooper, Nursery Supervisor
Clearfield

Clyde Hunt, Forest Geneticist
USFS, Upper Darby

J. U. Villesvik, W. Va. P&P Co.
Coudersport

J. A. Winieski
Harrisburg

Vermont
Kenneth Hovey, Nursery Supervisor
Essex Junction

Virginia
George W. King, Nursery Supervisor
Providence Forge

Thomas S. Turner, Nursery Supervisor
Charlottesville

I. F. Trew, W. Va. P&P Co.
Ivy

Virginia (Continued)

W. D. Lane, Nurseryman
Continental Can Company
Hopewell

Ray Marler, Research Chief
Virginia Div. Forestry
Charlotteville

West Virginia

Dave Penham, Nursery Supervisor
Parsons

James H. Parsons, Nursery Supervisor
Lakin

A. C. Allison, Asst. State Forester
Charleston

FIGURE 2--Example of Collection & Mailing Form
1963-64 Cooperative Cone & Seed Insect Survey

COLLECTION FORM FOR SEED & CONE INSECTS

Cone Species _____

Nursery _____ Location _____
(Town) (State)

Cone Collection Area _____
(Be as specific as possible)

Date Cones Collected _____ Date Insects Found ____

Your Estimate of:

A. No. cones in shipment _____

B. Percent cones damaged _____

C. Percent viable seeds destroyed _____

D. Damage symptoms _____

_____

_____

If insect damage was first observed in field during collection, what is your estimate of the degree and extent of the infestation.

_____

_____

_____

Entomologists Determination

(TEAR HERE)

INSTRUCTIONS FOR COLLECTING & MAILING INSECT SPECIMENS

1. Place as many of the insect specimens as possible in the vial containing 70% alcohol. Be extremely careful so as not to crush or puncture the specimens in any way.

2. Wrap the vial in tissue paper and place it in the bottom of the mailing container. Fold the completed collection form and place it around the inside of the mailing container.

3. Fill some of the container with parts of the cones which typify the damage caused by the insect(s) These would include hollow seed with entrance and/or emergence holes, damaged cone scales and rachises, and parts of cone containing accumulations of frass (boring dust).

4. Pack the remainder of the container with tissue or other packing material so the contents will not rattle or break in shipment.

5. Screw the metal cap on tight. Secure the cap to the container with masking or cellophane tape.

6. Mail to:

U. S. Forest Service
6 Main Street
Amherst, Mass. 01002

FIGURE 3--Summary of Cone and Seed Insect Collections Received From State Forest Nurseryman and Other Cooperators in Region 7 During 1963-64

Cone Species	Collection Location	Submitting Agency or Individual	Date Examined	Determination
White Pine	Charlottesville, Va.	W. J. Schroeder	7/31/64	1/Eucosma tocullionana
	Beaver Creek, W. Va.	A. C. Allison	7/22/64	No insect activity found
	Seneca State Forest, W. Va.	A. C. Allison	7/22/64	Conophthorus coniperda Dioryctria sp.
	Massabesic Exp. Forest	T. McConkey	6/16/64	Conophthorus coniperda
	Pennyrile St. Forest, Ky.	J. P. Rhody	12/11/64	No insect activity found
	Havre de Grace, Md.	R. L. Talerico	10/18/64	2/Dioryctria abietella 2/Conophthorus coniperda
	Wythe District-Jeff. N. F.	Clyde Hunt	5/25/64	Conophthorus coniperda CECIDOMYIIDAE
	Washington Crossing, N. J.	Clyde Hunt	7/6/64	Conophthorus coniperda Eucosma tocullionana
	New Haven, Conn.	Clyde Hunt	7/24/64	Conophthorus coniperda Eucosma tocullionana
	Rimel Coll. Area, W. Va.	Clyde Hunt	6/15/64	Conophthorus coniperda
	Clover Run Coll. Area, W. Va.	Clyde Hunt	7/30/64	Conophthorus coniperda Eucosma tocullionana
	Adirondack Region	E. G. Terrell	10/16/64	CECIDOMYIIDAE
Red Pine	Bennett Run Plantation, W. Va.	A. C. Allison	7/22/64	No insect activity found
Virginia Pine	Caron Springs, W. Va.	Clyde Hunt	8/11/64	3/Unknown-possibly DIPTERA
	Cabwaylingo Forest, W. Va.	Clyde Hunt	7/29/64	3/Unknown-possibly DIPTERA
Shortleaf Pine	Stearns District	Cumberland N. F.	12/4/64	No insect activity found
Balsam Fir	Savoy, Massachusetts	Roy Goodreau	10/3/63	Dioryctria abietella Megastigmus specularis LONCHAEIDAE (possibly Earomyia sp.)
	West Stewartstown, N. H.	Ingersol Arnold	10/4/64	LONCHAEIDAE (possibly Earomyia sp.) Megastigmus specularis Dasyneura sp.

Cone Species	Collection Location	Submitting Agency or Individual	Date Examined	Determination
	Greenbush, Maine	Clyde Hunt	7/14/64	MUSCIDAE (possibly *Eucosma* sp.)
White Spruce	Stratton, Maine	Clyde Hunt	7/20/64	3/*Pegohylemia* sp. (possibly *anthracina*)
	Highland Forest Fabius, N. Y.	Clyde Hunt	7/6/64	3/*Pegohylemia* sp. (possibly *anthracina*)
Norway Spruce	Essex Jct., Vt.	Clyde Hunt	7/20/64	3/Possibly *Dioryctria* sp.
Eastern Larch	Grafton, N. H.	J. Bean & R. Ford	7/8/64	CECIDOMYIIDAE
European Larch	Cooxrox Forest Stephentown Center, N. Y.	Dave Cook	9/24/64	3/Possibly *Dioryctria* sp.
Douglas Fir	Voluntown, Conn.	John Olsen	9/24/64	Cones in rearing

1/ Determination made by U.S.N.M.
2/ Determination made by R. L. Talerico
3/ Insect absent - Left cone(s) for pupation - Determination made on basis of damage, frass and discarded head capsules if present, and/or feeding characteristics.

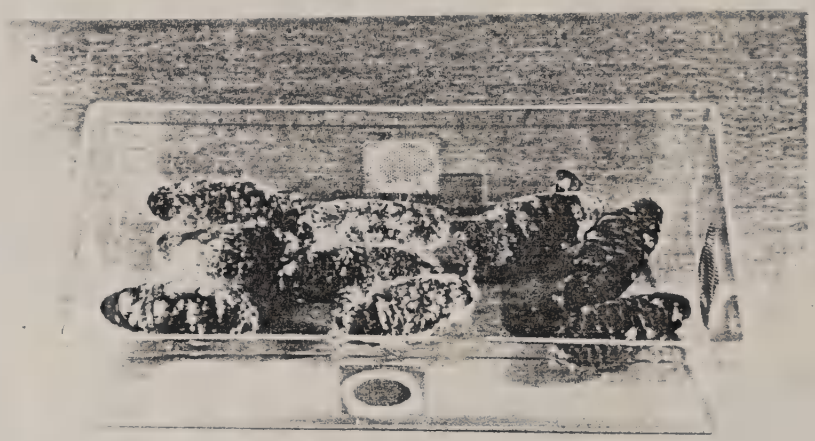

FIGURE 4--Plastic rearing container holding balsam fir cones. Mold is result of high temperatures and humidity.

FIGURE 5--Rearing containers for overwintering puparia of Earomyia sp. in balsam fir cones and larvae of Megastigmus sp. in red spruce seed.

IGURE 6--Second year immature cone of white pine showing entrance hole of the white-pine cone beetle, conophthorus coniperda.

FIGURE 8--Pupae of Eucosma sp. (left) and Eucosma tocullionana (right).

FIGURE 7--Eucosma tocullionana larva in immature balsam fir cone.

FIGURE 14--Frass exudation of Dioryctria abietella on Norway spruce cone.

FIGURE 15--Frass exudation of Dioryctria abietella on red spruce cone.

FIGURE 16--Clepsis persicana larva feeding on bracts of ovulating balsam fir flower.

FIGURE 17--Maggot of Earomyia sp. entering balsam fir seed.

FIGURE 18--Cross section of mature balsam fir cone showing seed damage by Earomyia sp.

FIGURE 19--Puparia of Earomyia sp. and damaged balsam fir seed from which they emerged.

FIGURE 20--Hatched egg of Hylemya sp. under bract of balsam fir cone.

FIGURE 21--Cross section if immature balsam fir showing anal portion of Hylemya maggot and circular feeding gallery.

FIGURE 22--Damage to white spruce cone by a single Hylemya (Pegohylemyia) anthracina larva.

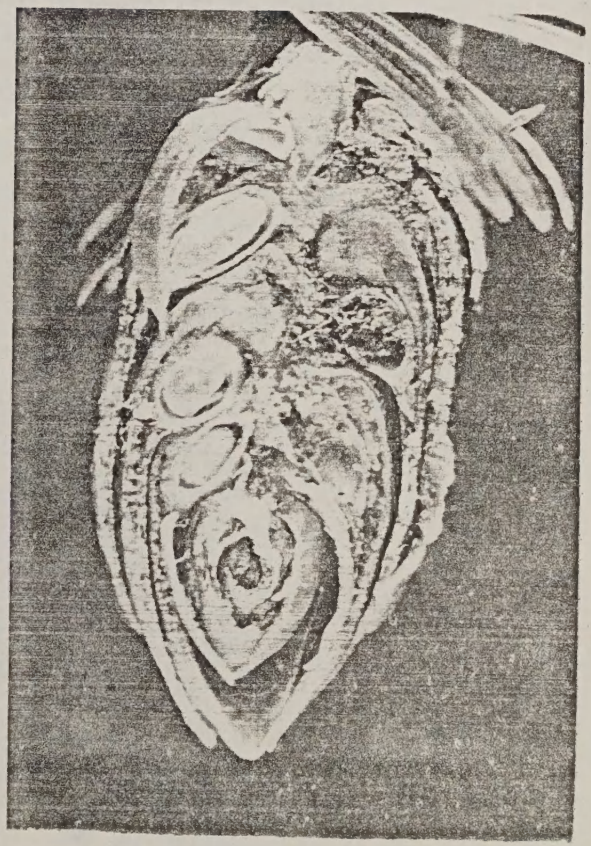

FIGURE 23--Injury to tamarack cone by a Cecidomyid midge.

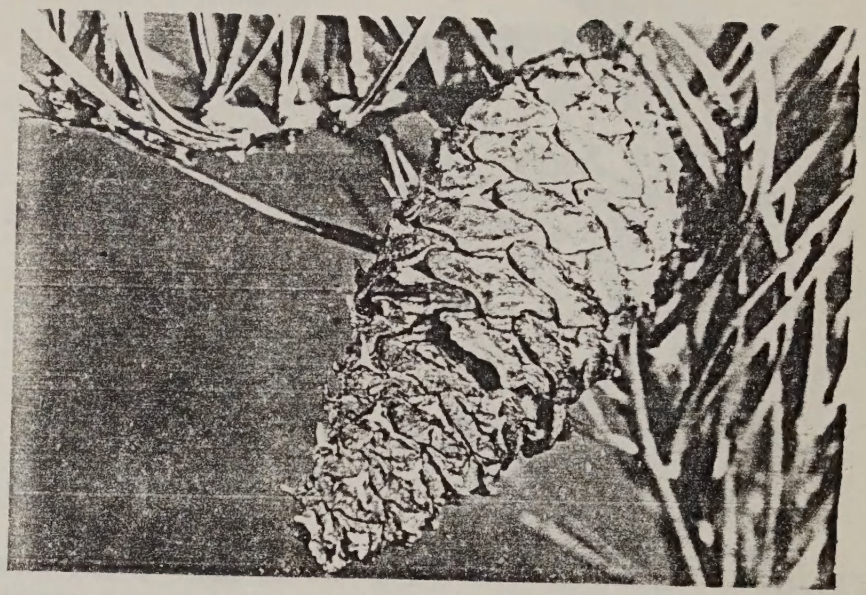

FIGURE 24--Virginia pine cone and exit hole of unknown cone feeder.

FIGURE 25--Female megastigmus specularis searching for oviposition site on a balsam fir cone.